Other specifications,[31] which include using a weighted linear term[32] of the distance from dump variable, also failed to demonstrate any systematic relationship between distance from the contamination site and property values.

Summarizing briefly the above results, one study area (Pleasant Plains) has confirmed our prior hypotheses.

- A statistically significant gradient is observed as expected for the Pleasant Plains, post-1974 sample.
- A statistically significant gradient is not observed for the Pleasant Plains, pre-1974 sample.

On the other hand, a statistically significant gradient is not observed for the Andover site. It is possible, therefore, to estimate the damages or the benefits of reducing the risks associated with contamination for the Pleasant Plains site only. However, it is not possible to do so in the Andover case.

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[31] In general, the results of variables other than the dump and landfill in the various specifications reveal that: of bathroom, bedroom, and room, bedroom proved consistently to be the strongest; housing density, housing unit density and water facility variables (MWTR, WWTR) were always statistically insignificant; junior and high school related variables were generally more significant than the high school variables, (see variable list in Appendix C), but this may be due to greater parental concern for the distance that younger children must travel; the sale date variable was usually strong irrespective of the form in which it was specified; lake view as well as housing characteristics except for basement were significant; locational variables tended to be unstable. Note from Table 30 that the R^2 was highest when neither the dump nor landfill were present.

[32] The dump variable was trended to assume a particular linear shape. The first quarter mile was assigned a value of 1 and subsequent quarter miles increased in value by 1. This is an alternative designation which serves to capture any possible effect of increases in distance on property values. The underlying assumption is that as one moves away from the source of contamination, everything else remaining constant, property values should increase.

C. Welfare Effects

Two steps are involved in measuring the damages associated with the Pleasant Plains site. The first step is to estimate the damages reflected in differential property values. The second step is to estimate total welfare losses by adding the costs of any amelioration activities.

1. Step I

Two methods for computing potential regulatory benefit estimates based on price effects were used for the Pleasant Plains site. Each method utilizes different assumptions about how the price effects generated by the presence of a hazardous waste site may be translated into damage estimates. Under Method I, it is assumed that the price changes observed in the sample of transactions used in this study (i.e., lots with residences) may be used as a proxy for damages which accrue to undeveloped land as well.[33] The potential welfare losses to owners of undeveloped lots are included using Method I. Under Method II, no assumption of this sort is made and the damages are estimated for lots with residences only. The results of these computations are presented below.

Method I	$7,819,284
Method II	$5,581,991

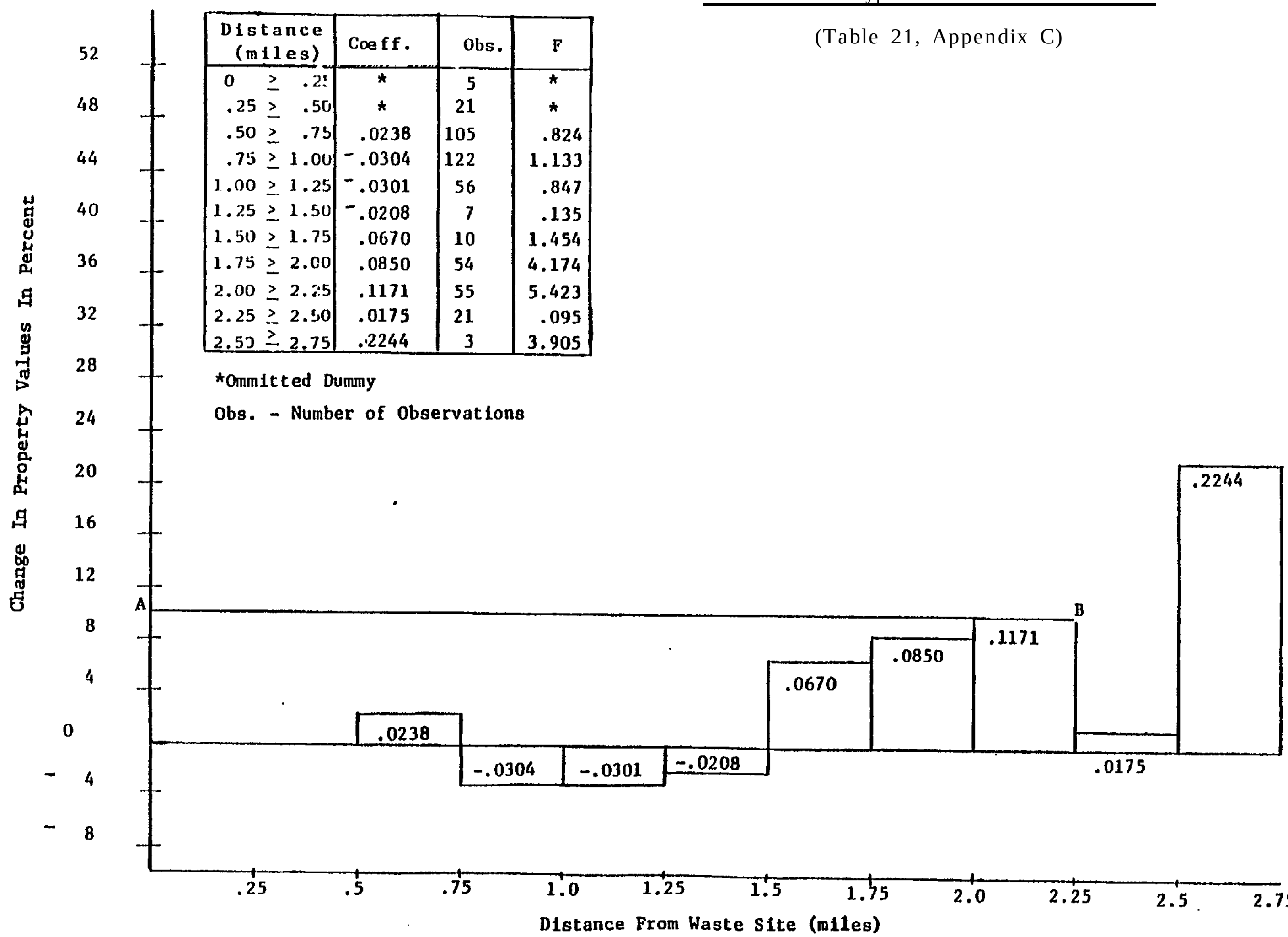
Computations are made by measuring the area between the post-1974 sample gradient and a hypothetical gradient which, it is presumed, reflects price differences which would be observed if the dump did not exist. The hypothetical gradient A,B is shown in Figure 8.

[33]It is not assumed that they may be used as a proxy for damages to commercial lots.

Figure 8

Post-1974 and Hypothetical Distance Gradients

(Table 21, Appendix C)



Distance (miles)	Coeff.	Obs.	F
0 ≥ .25	*	5	*
.25 ≥ .50	*	21	*
.50 ≥ .75	.0238	105	.824
.75 ≥ 1.00	-.0304	122	1.133
1.00 ≥ 1.25	-.0301	56	.847
1.25 ≥ 1.50	-.0208	7	.135
1.50 ≥ 1.75	.0670	10	1.454
1.75 ≥ 2.00	.0850	54	4.174
2.00 ≥ 2.25	.1171	55	5.423
2.25 ≥ 2.50	.0175	21	.095
2.50 ≥ 2.75	.2244	3	3.905

*Ommitted Dummy

Obs. - Number of Observations

The post-1974 sample gradient, as has been noted, is flat until about 1.75 miles out and increases at a fairly constant rate until 2.25 miles out after which the prices are not significantly different from price within 1/2 mile of the site. It is assumed for the purpose of ascertaining A,B that the coefficient associated with the 2.0 to 2.5 mile distance variable is close to the point at which prices are not influenced in any way by the dump, but we really do not now have enough data at this distance to be certain.

Damage estimates range from an average of $5,367 per house close to the dump to an average of $1,471, 1.75 miles away.

The actual computations are made in the following way:

a. The percentage increase in house values from the base (1/2 mile away) are calculated for each 1/4 mile zone.[34]

b. The number of lots with houses are calculated for each 1/4 mile area.

c. The number of vacant lots are added to the number of lots with houses for each 1/4 mile area.

d. "a" is multiplied by the base house price[35] (i.e., $45,836).

e. "c" is multiplied by "d" (This generates Method I estimates).

f. "b" is multiplied by "d" (This generates Method II estimates).

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[34] Each coefficient is subtracted from .1171 (the coefficient associated with observations 2 to 2.5 miles out). Those that are not statistically significant because of the way the gradient has been specified, i.e., they are not significantly different from the ommitted dummy variables close to the waste site, are assumed to have the same zero value.

[35] From the regression equation it is possible to compute the mean house prices in the area within .5 miles of the site by deducting from the mean of the dependent variable the sum of the weighted means of the coefficients of each quarter mile dummy variable.

2. Step II

The gross damage estimates include the costs borne by public and private agencies, including private firms, to ameliorate the problems experienced by property owners as a consequence of the dumping episode and/or to forestall potential future damages. Table 4 lists the estimates of costs that had been made by the New Jersey Environmental Protection Agency and that were available for our use. Before an adjustment can be made for deducting compensation paid by the private firm responsible for the incident[36], separate estimates are presented, one with compensation deducted and one with compensation ignored.

Total Damages (Damage reflected in differential property values and costs associate with amelioration.)

Using Method I (and excluding compensation)	$7,905,584
Using Method II (and ignoring compensation)	$8,115,584
Using Method II (and excluding compensation)	$5,668,291
Using Method II (and ignoring compensation)	$5,878,291

[36]This issue may be argued either way. On the one hand, compensation implies that the full burden of the externality is not borne by the householder or the public agency, in which case it should be deducted. On the other hand, since compensation of the sort paid by the private firm responsible for the dumping took the form of a lump sum transfer to present owners, it may not be expected to reduce the capitalized welfare loss measured by the price changes.

Table 4[1]

Estimates of Costs Incurred to Reduce Damages Potentially Done by Households[2]

(in dollars)

Clean Up Costs of Union Carbide	Unknown
Inspection or removal of drums	$ 10,000
Interim emergency water supply	4,900
Extension of public water supply	234,200
Cost of sampling and analysis	38,900
Construction of observation wells	8,300
TOTAL (ignoring compensation)	$296,300
Compensation	$210,000
TOTAL (excluding compensation)	$ 86,300

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[1]Data derived from M. Ghassemi, Analysis of Land Disposal Damage Incident Involving Hazardous Waste Materials, Dover Township, New Jersey, May 1976.

[2]The costs of capping wells, drilling new wells and the increased annual costs of water fell on the owner. These costs would, therefore, be expected to be reflected in property values.

VI. FURTHER DISCUSSION

The results generated in our analysis of the two sites seem to be consistent both with the prior hypotheses and with the known facts and anecedotal evidence collected about both cases. Anecdotal information obtained mainly from residents, collected at the time and in the course of our investigation, supports the empirical evidence presented in this study that house values were affected by the disposal of hazardous wastes in Pleasant Plains. The results of the Andover sites are also consistent overall with similar anecdotal evidence.

A. Pleasant Plains

The fact that in Pleasant Plains, property values did not respond more markedly to the incident may be explained by the speed at which intervention occurred--the site was cleaned up before 1974, and a municipal water supply was installed and connected within a month of the discovery of contamination. Another factor possibly mitigating against a larger price effect is the lack of any demonstration of contamination in Pleasant Plains since 1976.[37] This suggests that the impacts of the dump site on Pleasant Plains could have been short-run, rather than long-run. However, we found the price effects to be more lasting, extending throughout the period for which the sample 1 data were collected.

On the other hand, there may be actual or feared health risks involved with living in an area in which the groundwater is contaminated. Further, public opposition to the sealing of private wells suggests that there are some damages other than those which would be incurred by installing a municipal water supply, etc.

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[37] Recently contamination was discovered just north of Pleasant Plains.

The exact nature of these perceived damages is not known. Distance and zones of contamination were used in this study as proxies for the damages ~~affected by~~ hazardous waste sites. They do not reflect which of the possible effects property values reflect, i.e., individual well contamination, contamination in the area, the loss of the preferred private wells, etc.

It would be possible to specify distance or contamination proxy variables to provide more information on the specific nature of the perceived damages. However, more detailed data would be required on the specific wells contaminated to improve the contamination variable. An alternative approach would be to allow the distance variable more flexibility so that it could more accurately describe the pattern of response to contamination. In the study, distance was expressed in concentric circles. Yet, there is no reason to believe that contamination moves at the same speed in all directions.

B. Andover

The results of the Minneapolis site are also consistent overall with other kinds of evidence collected during the period of study. It has been concluded that the analysis failed to produce the necessary statistically significant results that would demonstrate that property values close to a site of contamination will be permanently impaired, irrespective of whether contamination is widespread.

Several possible explanations of this result may be put forward. One is that the current contamination is not very substantial, nor is it even perceived to be an immediate threat at all. So far only 3 wells, all of which are located on the same property as the hazardous waste site, have been found to be contaminated. Of the compounds detected, only 3 are present in concentrations that exceed levels judged to be safe for human tolerance. They are: Methylene Chloride; Perchloroethylene, and Xylene.

Perhaps the primary factor in maintaing property values is that the 3 contaminated wells all draw on shallow aquifers, whereas the wells in the surrounding communities draw on different aquifers.

The current state of knowledge also implies that the possibility for extensive groundwater contamination exists, but its future contamination depends on the types of seal that are used to finish the surrounding wells. Further investigation of such issues are contingent upon steps taken by the U.S. Environmental Protection Agency. These tests should establish the extent of current contamination and the direction and speed of the spread of contamination.

The relative strength of the landfill variable (compared with the waste dump variable) could be a function of prior knowledge of the landfill as a garbage facility. The landfill is owned by a statewide garbage disposal service and has been in existence for 30 years. Hence, there has probably been some capitalization effect of the negative externality associated with garbage.

On the other hand, the association of the dump site with hazardous waste is relatively new and residents simply may not have adjusted as quickly as was expected. Other factors, such as the frequency with which hazardous waste sites are discovered and their prevalence in this part of the country, could numb residents to further news on the subject where there appeared to be no immediate threat. Moreover, the containment of the contamination to the property of the dump owner has perhaps influenced the perception of residents as to the potential hazards.

VII. CONCLUSIONS

Several conclusions with respect to the effects of hazardous waste sites on property values may be drawn from the empirical evidence accumulated in this study.

From our analysis of the theory, it has been demonstrated that there should be a link between property values and hazardous waste sites. Further, the approach has been shown to have merit insofar as it can be used to obtain reasonably reliable benefit estimates.

While there is no established theory linking distance and risk, distance has served in this study as a proxy for the impacts of the hazardous waste site. It was found to be more useful than the officially defined zones of contamination. Indeed, the officially denominated zones of contamination in the study have been found to be unreliable. The problem of defining such a zone seems to be complicated by inconsistent monitoring results.

Of the empirical results, those for Pleasant Plains were determined to be consistent with the hypothesis, i.e., a statistically significant gradient was observed from the source of contamination in the sample of sales transacted after the contamination episode. Further, no statistically significant gradient was observed in the sample of transactions made before the contamination episode.

The results for the Andover sample are not consistent with the hypothesis, but this may be because the problem at Andover has been relatively insignificant so far.

APPENDIX A

Land Value Theory

by

Robert C. Anderson

and

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Preface

Appendix A constitutes the foundation for the theoretical discussion in Chapter II. In this capacity, it analyzes the theoretical basis for studying the relationships between land values and proximity to a hazardous waste site. It does this by examining the strengths and weaknesses of theories which explain the relationship between environmental quality and land values and by examining specific methodologies used in empirical investigations of this relationship.

In another dimension, this Appendix serves as a literature review and thereby provides a starting point for the empirical investigation.

I. INTRODUCTION

The disposal of hazardous wastes is a complex subject that has attracted the attention of lawmakers, governmental regulatory agencies, the media and the public. Although the interests of these groups vary, two generic policy issues have surfaced:

1. Certain existing disposal sites pose threats to human health and welfare. What level of remedial action or compensation to the victims is appropriate?
2. New facilities create a disamenity when located in or near an urban area. What types of controls should be used to avoid undesirable risks to health and welfare and what payment is needed to compensate nearby residents for the disamenities associated with the facility?

These questions involve one common theme: the need to measure the benefits of reduced risk from the disposal of hazardous waste; in other words, the damages from exposure to the risks of hazardous waste disposal. Economists have identified several distinct conceptual approaches that, in principle, could be used to measure the relevant benefits or damage functions for non-market commodities like health and environmental risks. One method is to measure current and anticipated physical damages and then place appropriate economic values on these effects. A second method is to survey individuals directly concerning the amounts they would pay to reduce risk or the compensation they would demand to bear greater risk. A third approach is to analyze voting behavior when decisions such as hazardous waste siting are subject to a referendum. A fourth method uses prices in related markets to infer the values individuals attach to non-marketed goods and services. An example of this approach is the use of property values to estimate the value of different characteristics of properties, including proximity to hazardous waste facilities.

This study focuses on the last approach--the use of property values--to estimate the values individuals attach to risks and other disamenities associated with proximity to disposal sites. Two hypothetical situations help to clarify the approach. First, suppose a hazardous waste facility is sited in a remote area far from residential neighborhoods. Through the processes of urban growth, surrounding land is slowly developed until new residences are being constructed in close proximity to the waste facility. Most people would likely deny that those buying new residences in the area merit compensation for the disamenity, providing they were informed before purchasing. On the other hand, it is often politically important to know the extent to which property values will be affected and how to interpret any measured impacts.

The second situation involves the siting of a hazardous waste facility in an industrial park within close proximity to an established residential neighborhood. Some residents will find their satisfaction diminished. If the transaction costs of moving are not too large, they may offer their homes for sale and attempt to find a replacement home without the disamenity. Even if transaction costs do inhibit some from moving, other residents will leave the area as a normal consequence of corporate transfers, retirement, and divorce. To whom will these homes be sold? Assuming individuals are not homogeneous with respect to tastes and preferences, the homes will be purchased by those who place the smallest negative value on the disamenity, for to them discounts from prevailing price levels will make the properties seem to be a bargain.

To others with less tolerance for the disamenity, the property may seem grossly overvalued relative to other alternatives on the market.

Several observations can be made regarding this example. First, changes in price tend to reflect changes in value to those individuals who are least sensitive to the disamenity, not the change in value to the average person. Second, changes in price may not reflect actual losses to existing owners for reasons that include transaction costs of moving and anticipation by some owners prior to their actual purchase that a facility would be located nearby. Third, multiple sources of amenities and disamenities in the neighborhood may make it extremely difficult to sort out the separate impacts of a nearby waste facility.

The remainder of this Appendix is divided into, three major sections. The next section is devoted to a fuller treatment of the links between environmental quality and property values, by reviewing theory linking the two, examining various alternatives for measuring impacts and reviewing several empirical applications. The third section of this paper examines more fully the issue of using property value changes as an indicator of benefits or loss of benefits. Both theoretical and empirical applications are reviewed.

The last section discusses the potential for applying property value analysis to the siting and control of hazardous waste facilities. The section notes special characteristics of hazardous waste disposal sites that make property value analysis for them more complex than the existing empirical applications for noise, solid waste disposal, and air and water pollution. The section concludes with descriptions of a set of two interrelated studies to determine the impacts, if any, of hazardous waste disposal facilities on nearby property values.

II. LINKING ENVIRONMENTAL QUALITY TO PROPERTY VALUES

To argue that property values can reflect the economic benefits of varying levels of environmental quality, it is necessary to establish first how environmental quality affects the land market. Perhaps the simplist way to visualize this relationship is to consider land prices for specific parcels as the discounted stream of net benefits attributed to each parcel. Observed market prices reflect transactions among individuals, the transactions resulting from the different values attached to the property by the buyer and the seller. To the extent that environmental quality affects the net benefit stream received from holding a parcel, the value of the parcel to the owner will rise or fall. For example, an increase in pollution levels in an area, everything else held constant, should decrease the net benefits of residential property (benefits fall or costs rise depending upon the point of view taken). Everything else being equal, one would expect that the price for the residence would be lower in the presence of greater amounts of pollution.

This relationship can be stated more formally in terms of the utility functions of land market participants. If environmental quality affects the utility derived from purchases of land or if environmental quality enters directly into individual utility functions, property values may be affected. Either situation is sufficient to ensure that environmental quality appears as a factor in the demand for housing and, therefore, the choice of residential location. This view is consistent with the recognition that housing is a heterogeneous commodity, a collection of characteristics that are distinct to some degree. That is, the demand for housing is dependent on such characteristics as the number of rooms, distance to recreation or work, building material, and environmental quality.

In attempting to validate empirically the relationship between property values and environmental quality, most analysts have applied the technique that is now termed "hedonic theory." This theory shifts the focus of housing demand analysis from the commodity "housing" to its underlying characteristics, including environmental quality. Much of this section will be devoted to a description of hedonic theory and its empirical application.

A. Hedonic Theory

Hedonic theory begins with the utility function of households,

(1) $U = U(X,H)$

where X is a vector of private goods excluding housing, and H is a vector of housing attributes or characteristics. The utility function is taken to be quasi-concave and continuous in first and second partial derivatives. The budget constraint for a representative household is:

(2) $PX + ZH = Y$

where P is a vector of private good prices excluding housing and Z is the hedonic price function relating housing prices to their characteristics.

The consumer's choice process over housing can be represented by a two stage process. First, the consumer maximizes utility subject to the budget constraint with housing consumption held fixed. This produces What has been termed an indirect utility function.

(3) $F[P,Z,Y - Z(H)]$

This function determines the maximum utility that the consumer can obtain, given the prices of market goods, when he resides in a dwelling with characteristics H costing the amount Z(H). In the second stage, the consumer chooses houses that maximize the indirect utility function (3). The focus of hedonic theory is on the function Z(H), or the hedonic price function, which depicts the individual prices z_i for characteristics h_i. A subsequent section will deal with the problem of identifying and estimating demand functions for the characteristics.

The coefficient z_i of the hedonic price function represents the additional amount that must be paid on the average property to acquire an additional unit of characteristic h_i, holding everything else fixed. For example, a linear hedonic price function for housing might be specified as:

$$(4)\ PV = ZH = z_o + z_1h_1 + z_2h_2 + z_3h_3 + \ldots$$

where:

PV = the property value

h_i = house size in square feet

h_2 = distance to central business district

h_3 = a measure of environmental quality

z_i = the price of one unit of the i^{th} characteristic

The equation is not observable directly, but can be estimated statistically from data on market transaction prices for properties. The estimated coefficients z_i can be interpreted as implicit prices. For example, z_3 could be taken as the price of a unit change in environmental quality for the average property in the sample.

It is important to note that implicit prices will only be reflected in the land market for those goods that people can evaluate. In terms of environmental quality only those characteristics that are reasonably well known or understood will be capitalized in land values. It is not necessary, though, that there be a direct relationship between a physical damage function and individual utility functions. It is sufficient that market participants associate a particular land parcel with particular environmental quality characteristics. Nevertheless, to the extent that land market participants are poorly informed on environmental quality or do not detect certain environmental effects (such as chronic health effects), implicit prices for environmental quality will be downward biased. The critical role played by information in hedonic property value studies will be discussed further in the section on hazardous wastes.

B. Applications of Hedonic Analysis to Property Values

Literally dozens of papers have used some form of hedonic analysis in attempts to exploit its ability to isolate the importance of various factors that explain property values. Frequently, the principal focus of the studies was not of particular interest to the subject of this paper. Consequently, this review ignores many of the papers where the principal focus was on topics such as the price or income elasticity of demand for housing.

An early example of hedonic price analysis is offered by Ridker and Henning (1967). They used a hedonic regression to explain property value differences among census tracts in St. Louis. Included among their explanatory variables were neighborhood characteristics and measures of air pollution. They interpreted the coefficients of their air pollution variables as measures of the willingness to pay for an overall reduction in air pollution in St. Louis. At least 15 subsequent studies have examined the relationship between property values and air pollution.

These studies provide some validation to the hypothesis that environmental quality affects property values. Of the 15 studies reviewed in Freeman (1979), 12 show air pollution as having a depressing effect on property values, as expected. In some cases, the results are remarkably similar, given the different data bases, model specifications, and variable definitions. For example, the Anderson-Crocker (1971) and Polinsky-Rubinfeld (1977) studies both used property values by St. Louis census tracts in 1960. Their pollution variables were the same, but the remaining explanatory variables differed slightly. Their results for owner occupied property value impacts implied a composite elasticity (for sulfation and particulates) of .1 to .2.

Several studies have examined the effect of nearby non-residential land uses on the price of residential properties. Although the results of the studies are mixed with some showing a price effect and others showing no effect, the studies do provide useful insights for modeling the relationship between hazardous waste disposal activities and residential, property values.

Havileck, et al., used a hedonic price function to estimate the external effects of solid waste disposal sites (landfills) on property values. Sales prices of single family homes, over the period 1962-1970, around five waste disposal sites were regressed on variables describing the physical attributes of the housing, the year of sale, the distance from the nearest disposal site and the downwind direction from a site. Dummy variables were also included to account for differences among the disposal sites. The estimates from the regression indicated that for every one foot difference in distance from a property site, values increase on the average by $.61, and for every degree away from the downwind of a site, values increase by $10.30.

A study by Crecine, et al., found that for a number of areas in Pittsburgh there was no systematic evidence that the value of single family homes was affected by the presence of nonresidential land uses in adjacent land use blocks. Their explanatory variables included the percentage of various nonconforming land uses--such as two-family residences, multiple family dwellings, retail stores, commercial services, cemeteries and vacant land. Similar results were obtained by Reuter using a better data base.

Rain and Quigley found that data from St. Louis indicated that the presence of commercial and industrial structures on a parcel's block face had a statistically significant negative effect on the price of single family houses and apartment rents. Stull found that for a sample of 40 suburban towns in the Boston SMSA, multiple family use and industrial land use had a negative effect on single-unit, owner-occupied homes.

Grether and Mieszkowski used data from New Raven and surrounding communities to examine the effect of several types of nonresidential land use. The authors were careful in their choice of sites for the separate "experiments" to find areas affected by only one nonconformity to single-family use. Included as "experiments" were properties surrounding an elevated turnpike, commercial strips, industrial development, multiple family housing units, and small commercial developments. They chose a semilogarithmic specification largely because of simplicity (the natural log of value was regressed on observed values of the explanatory variables). In that specification, each separate explanatory variable adds or subtracts a constant percentage amount from value. Their data spanned the years 1954-1970. To account for changes in price over the period they included a time trend (specified as three separate rates of growth for the periods 1954-1958, 1959-1963, and 1964-1970). Proximity to the source of nonconformity was specified as distance and the square of distance. Sample sizes ranged from 76 to 383 in the 16 separate experiments. The authors felt that some of the samples were quite small for this type of analysis and claimed not to be surprised that the distance variable was significant in only five of the experiments at the .05 level and in only three of the experiments at the .01 level. They concluded that non-residential land use, per se, did not have a systematic effect on values in their samples.

Two other recent papers on hedonic price functions considered explicitly the effect of non-residential uses. Jud developed a variation of the hedonic price model to investigate the effects of zoning and neighborhood land uses on the value of single family residences. His model differs somewhat from the typical specification in that the dependent variable is defined as market price per square foot of structure rather than simply market price. Jud's rationale for this specificaiton was that it gave more consistent results; he did not offer any theoretical rationale to support the specification, however. The neighborhood land uses that were investigated included industrial, commercial, and vacant. A quadratic functional form (X_i and X_i^2) was estimated for each neighborhood land use variable to allow for the possibility of a nonlinear relationship. As a rationale, Jud notes that a few commercial establishments nearby might lower property values because of congestion but a large shopping center could actually enhance values.

Jud used a sample of 3,513 transactions--all of the single family sales in the city of Charlotte, North Carolina, for the year 1970. Be estimated both a linear and a semilog model. For both models the neighborhood variables, percentage of land devoted to commercial and industrial use, and the square of these variables were significant at the .05 level.

Li and Brown estimated a hedonic price model that focused on the effect of micro-neighborhood externalities on the price of single family homes. They postulated that such micro-neighborhood characteristics as proximity to a grocery store, a river, a neighborhood park or conservation land would have two types of effects: a positive price effect associated with accessibility to a desired non-residential activity and a negative impact arising from congestion, air pollution and noise. They anticipated that the sum of the two effects would produce a net positive effect that increased with distance up to some most-valued location and then declined monotonically thereafter toward zero.

The Li and Brown study obtained a sample of 781 sales of single family homes in the southeast sector of the Boston metropolitan area from 1971 records of multiple listing real estate firms. Sales price was hypothesized to be a function of (1) structure and site characteristics, (2) neighborhood characteristics, (3) local public service and costs, (4) accessibility to the central business district of Boston, and (5) micro-neighborhood characteristics such as pollution, aesthetics and distance to nonresidential activities. The authors devoted most of their attention to a linear specification, using sales price as the dependent variable. They also noted that if all characteristics of size are multiplicative in their effect (e.g., doubling size doubles the effect of an extra bathroom) and the error term is proportional to size, the equation can be estimated with price per room or price per unit of land area as the dependent variable and all other explanatory variables as per the initial specification.

The empirical results confirmed their hypothesis regarding the two opposing effects of micro-neighborhood externalities. For distance to industry, to commercial areas, and to the major thruway both the positive effects of access and the negative effects of congestion, noise and pollution were significant (or nearly significant) at the .05 level.

A final example is Nelson's paper which investigated the impact of the Three Mile Island nuclear accident on residential property values around the plant. Specifically, he was interested in determining whether the accident resulted in a statistically significant decrease in housing prices within five miles of the plant. His hypothesis was that lasting long-term concerns resulting from the accident would be reflected in a dimunition of land prices. Nelson's two-part study first analyzed, within a hedonic price framework, housing prices in two small communities surrounding the plant over a two-year period before and after the accident. The second section statistically analyzed all sales price data within five miles of the plant and compared rates of change with outside and control estimates. We focus here on the first section as being more directly relevant to our questions.

Nelson's hedonic analysis utilized samples of 47 and 53 observations, respectively, for the two communities. Observations on housing sales were collected from county assessment cards and covered the period January 1978 through December 1979. The nuclear accident occurred on March 28, 1979. For the first community (Oak Hills) there were 19 sales after April 30

(Nelson assumed that any sales between March 28 and April 30 were agreed to before the accident). Valley Green Estates, the second community, had 22 "after" sales.

The model used by Nelson was:

$$SP = a_0 + a_1X + b_1T + b_2(TMI) + b_3(TMI.T) + U$$

In this specification, SP is the sales price and X is a vector housing characteristic. For the Oak Hills equation these variables included square feet of living space, lot frontage, and dummy variables if the house was semi-detached, had a basement, had a brick exterior, had certain housing extras, or if the house was built after 1974. The T variable is a trend variable taking on a value of 1 for the first quarter of 1974, and so forth. It was intended to capture general changes in market prices over time. The TMI and TMI.T variables are dummy variables to test for possible shifts in the slope or constant term of the equation after the accident. TMI equals 1 if the sale was after April 30, 1979. It is noteworthy that a distance variable was not included in the equation (the implicit assumption was that properties would be affected similarly by the accident regardless of the exact distance from Three Mile Island).

Three equations were estimated for both communities; one equation included both TMI and TMI.T and the other two equations included the variables separately. In general, the estimated coefficients for the housing characteristics carried the expected positive signs and were significant at the 95% confidence level (one exception was the dummy variable for semi-detached homes which was negative and insignificant). On the other hand, not one of the TMI variables was statistically significant. Nelson interpreted this result to suggest that the accident could not be associated with a change in housing prices.

Nelson suggests three reasons why his model was unable to detect a property value effect of the accident: (1) there is the possibility that the time period covered by the analysis was too short to allow market adjustment; (2) residents may have perceived the costs of the accident as being short-run in nature; (3) the residents may have expected federal and state assistance, the positive effects of which may have offset any negative impacts from the accident.

Nearly all of these studies have discussed to some extent the specification of the hedonic price equation: the variables to be included and the functional form of the equation. While there seems to be general agreement about the proper variables to include, the proper functional form has not been agreed upon. Some authors prefer a linear form and others a semi-logarithmic form. Some use a dependent variable expressed simply as sales price, while others use price per unit land area, price per unit house area, or price per room. Halvorsen, Pollakowski, Ellickson, and Bender, et al., have all developed flexibile estimation procedures patterned after Box and Cox which permit comparison of many alternative specifications. Their work shows that the coefficients can be sensitive to the specification that is chosen.

C. Time Series Approaches

An alternative to cross-sectional methods for estimating the effects of changes in environmental attributes on property values is to compare property values before and after a change in environmental quality. An early example of this approach is Ridker's 1967 study which used both time-series and cross-sectional approaches to estimate air pollution control benefits. However, pure time-series analysis has not been used often to measure the value of environmental amenities, principally because of the difficulty of controlling other time-related influences on property values. There may be instances, however, where this technique would be appropriate.

Critical to the use of a time-series approach is the development of a real estate price index. A useful reference on this point is the review of Palmquist which compares results of two methods, one using pairs of transactions on the same properties and the other, a hedonic equation on different properties with time as a characteristic.

Several of the studies reviewed earlier in this section used time as a characteristic in cross-sectional regressions of housing prices on housing attributes. Some analysts have questioned this approach because the hedonic price equation may be misspecified or incompletely specified. Thus, the estimated variation in prices over time (as in this study of Three Mile Island) may err because important variables that are correlated with time (such as the size of new dwellings) have been omitted. The alternative approach to measuring changes in prices over time relies on pairs of transactions for a sample of properties, thus holding quality fixed. Palmquist also improved on past studies using the repeat sale approach by incorporating a factor for depreciation. He showed for his sample that without the depreciation correction the hedonic and repeat sale methods yielded statistically identical results. When depreciation is considered, the two methods differed in their estimate of price changes over a 15 year period by as much as 7 percent.

Another example of time series analysis of property value changes is Anderson and Dower's analysis of the impact of land use controls imposed by the Adirondack Park Act in New York. In this study, price indices for land values in different land use classes were estimated using repeat sales data for periods before and after passage of the Act. They found that the more restrictive the land use controls, the greater was the impact of the 1973 Act on property values.

Up to this point, the emphasis has been on different attempts to isolate the property value impact on the implicit price of a particular land characteristic such as environmental quality. Although these impacts may be of great political interest, from an economic or policy viewpoint the benefits of environmental quality ~~is~~ are of more significance. A growing, and still controversial, body of literature concerns how the implicit prices obtained from a hedonic price function can be used to estimate benefits. The next section presents a general overview of the major issues.

III. ESTIMATING BENEFITS

Early on, Rosen showed that the indirect utility function, given by equation (3), could be given a useful interpretation in terms of the consumer' marginal willingness to pay for characteristics of a composite commodity. The coefficient of the characteristic in the hedonic price function can be interpreted as the marginal willingness to pay for an additional unit of the characteristic.

If marginal willingness to pay can be taken as constant for all units of a characteristic and all households have the same tastes and preferences, benefits can be derived directly for a given change in the amount of a particular characteristic that is supplied. This set of assumptions is relatively common in the literature that attempts to derive benefit estimates for changes in environmental quality using the hedonic approach.

An example of a study using this approach is Barnard's analysis of the impacts of increased flooding probabilities resulting from urban development in Iowa City, Iowa. Barnard estimated a hedonic price equation for single family residences in the area and took the coefficient of the flooding probability as a measure of a constant marginal willingness to pay to reduce the chances of flooding.

Another similar example is given by Brown and Pollakowski. They developed a hedonic model to estimate the impact on property values of proximity to urban shoreline and the effects of buffer zones of undeveloped land surrounding lakes. The policy question of interest to them was the ability of regional planners to determine the optimal amount of undeveloped land to provide thorough zoning restrictions or public purchase of land surrounding lakes. To answer this question the authors first developed a hedonic equation for property characteristics. In the second stage, they assumed marginal willingness to pay was constant and that all households were identical in taste and preferences.

The Brown-Pollakowski hedonic price model estimated the implicit prices for housing attributes, including proximity to lakes and depth of open space surrounding the lake, for homes around three lakes near Seattle. One of the lakes was surrounded by a setback (or buffer zone) of varying width while the other two had no setback. The sample areas were chosen for their high degree of neighborhood homogeneity, easy access to the lakes, and variations in setback width.

The authors used data on market sales for residences around the lakes during the years 1969-1974. Sales data and descriptions on housing attributes were obtained from monthly publications of the Seattle Real Estate Association Market Data Center, Inc. The basic equations estimated for the three areas (the two samples with no setback were pooled into one equation) were linear expressions of sales price (deflated to 1967 dollars) as a function of living area; age of house; average room size; number of fireplaces; number of car garage; number of first floor rooms; number of bathrooms; dummy variables for the existence of a basement, dishwasher, range or oven, wall or floor heating, and electric heating; distance to waterfront; and individual setback size. These last two variables were included in log form. The authors argued that the relationship between sales price and distance or setback size was non-linear. Specifically, they assumed that as distance or setback width increased, the sales price premium increased at a decreasing rate.

The estimated coefficients of the two equations were generally of the appropriate sign and statistically significant. The R^2's were .84 and .78 for the setback and non-setback samples, respectively. The coefficients of the setback width variable indicated residences adjacent to 200 and 300 foot buffer zones would sell for approximately $850 and $1,350 more than one located next to a 10 foot zone. The estimates also showed that distance premium decreased more quickly in the non-setback equation than the setback sample.

The regressions results were used to provide rough estimates of the benefits from open space by interpreting the marginal implicit price function as marginal willingness to pay. That is, the derivative of the hedonic price equation with respect to setback width was taken as the demand curve for open space around lakes. This transition required several assumptions: first, that the housing characteristics were unique to home purchases and that buyers' and sellers' utility functions were weakly separable in housing services; second, that there is a high degree of inter-urban area mobility; third, that households have equal incomes; finally, that households have identical utility functions. Given these assumptions, Brown and Pollaskowski were able to estimate benefits to homeowners, the added value to property caused by marginal changes in the width of setback. Optimal open space was then estimated by comparing the benefits to the costs of providing additional open space. The results of the study were used by the authors to justify subsidies for private efforts to establish open areas or government intervention to provide public areas around water bodies.

Rosen and Freeman (1974) have argued that the coefficients of the hedonic price equation are actually points of equilibrium between the supply of particular characteristics and the demand for the characteristics. One special case that makes identification of the demand curve easier is if all households have the same income and taste so they can be represented by one willingness to pay curve. Then the willingness to pay curve is simply the marginal implicit price function. This assumption was made implicitly by Ridker and Henning and has been explicit in the studies of Brown and Pollakowski, Barnard and others. A second special case simplifies the estimation of demand for attributes if supply is fixed. Then the marginal implicit price function is the inverse of the demand function. This is the approach taken by Harrison and Rubenfield (1978).

If supply is fixed, and the other assumptions concerning the constancy of marginal willingness to pay and identical utility functions are satisfied, the simplified procedure of Brown and Pollakowski, Barnard, and others would be valid. But supply cannot necessarily be assumed to be fixed. Neither is it necessarily reasonable to assume that all households have identical incomes and identical utility functions. Rosen and Freeman argued, in essence, that for the more general situation, demand curves for separate characteristics could be derived from the coefficients of the hedonic price function. The basic procedure is as follows.

In the hedonic price function, specify a nonlinear relationship between price and the attribute of interest (a linear relationship would provide no price variation and no hope of identifying demand equations).

From this estimated relationship for the price of the attribute of interest, generate a "price schedule" for all homes (or census tracts) in the sample. With this price schedule and observations on the quantity of the attribute that is consumed, household income and other taste shifters such as education or age, estimate a demand equation for the attribute of interest.

Nelson (1978) took a somewhat different approach in actually specifying a supply function. The two equation model Nelson used to generate demand curves for improved air quality has been criticized as ignoring some supply-side adjustment process. A more recent simultaneous equations study by Witte, et al., (1979) looked more closely at the supply side in their housing market study. Although they developed and estimated an intersecting simultaneous system, it did not include environmental quality parameters.

The procedure outlined by Rosen and Freeman has been criticized in some as yet unpublished papers (see Mendelsohn, for example). The argument is that the hedonic price function estimated from cross-sectional data identifies a price schedule for different quantities, but not true price variation. Only one point on each willingness to pay function can be obtained. Thus, the second stage estimation process is probably not producing valid estimates of demand for attributes but merely rearranging the information in the hedonic price equation.

IV. APPLICATION TO HAZARDOUS WASTE SITES

In the most general sense, the regulatory interest in hazardous waste sites involves the potential risk to human satisfaction and the environment. The issue to be addressed in this section is whether risks from these sites and willingness to pay to reduce the risks can be measured from property values. Following most of the studies discussed earlier, the actual manner in which risk enters individual utility functions will not be investigated. Rather, it is assumed that risk affects utility through identifiable characteristics of properties. A more definitive treatment of risk is usually not encountered in empirical studies of property values and is beyond the scope and needs of this study. By way of introduction, it is useful to highlight two special characteristics of hazardous waste problems that will affect any property value study.

A. Routes of Exposure

The potential for adverse effects from hazardous waste disposal results from the possibility of human or environmental exposure due to leaks, spills or explosions from improper handling of the wastes or accidents. These events are translated into exposures when the wastes come into contact with humans or the environment through contamination of air, ground and surface water or soil. For example, of 169 remedial action sites studied by EPA, 110 sites were associated with groundwater pollution, 95 with surface water pollution, 49 with air pollution and 69 with soil contamination.

This fact that exposures can take place through various media has significant bearing on the applicability of the typical hedonic property value equation to hazardous wastes. In the case of air or noise pollution, the environmental (levels of pollution) variable can be measured reasonably well by monitoring stations within an urban area. However, a similar monitoring system has not been developed for hazardous waste sites. Where monitoring is done to meet federal and state regulations, it generally does not include the contaminant levels in all of the media that may be routes of exposure. Also, the wide range of hazardous substances that typically constitute wastes at a particular site complicate the issue of defining a single indicator pollutant such as SO_x or particulates. For example, a hazardous waste site in Michigan was found to contain over 30 chemical compounds, 17 of which were either toxic or a known carcinogen, mutagen or teratogen. Given this measurement problem, it may not be possible to define a good measure of environmental quality near hazardous waste sites. Alternative and much cruder measures of quality, such as proximity or the existence of contaminated private wells, may be all that can be objectively measured.

B. Public Perceptions and Information

It was noted earlier that land prices reflect only those amenities that are understood or perceived by land market participants. In other words, the risks associated with hazardous waste sites will be capitalized in land values surrounding the site only if the public is aware of the existence of the site and its risks. Although public awareness certainly exists for several sites, many sites have gone undetected for years. Further, of the numerous media through which a site poses health and environmental risks, some may be noticeable and others may not. For example, certain consequences (such as odors) of air pollution from a particular site will almost surely be realized by nearby residents. On the other hand, minute but unhealthy levels of chemicals in drinking water may go unobserved. Clearly, the absence of a property value differential in the latter case could not be interpreted as zero willingness to pay.

The general point is not just of isolated interest. In fact, the environmental problems with hazardous waste sites often go unnoticed until government actions uncover the real risks. This could lead, as noted by a reviewer of an earlier draft of this section, to a rather strange effect. To the extent that government clean-up efforts reveal information on site risks that had been unknown, clean up could be associated with increased costs to home owners as the information is translated into lower property values.

The interpretation of property value impacts from hazardous waste sites may also be complicated by the timing of effects. Studies on the land price impacts of industrial or development activity reveal that land price differentials will often vary over time in distinct stages. These effects may reflect changes in the public's attitude toward the development. For example, land prices may fall at first as residents learn of the development plan and then rise as land market participants see an opportunity for speculative gains or the public becomes used to the idea.

This concern over timing of price effects may have significant bearing on hazardous waste site property value studies. One can imagine a time profile of price impacts associated with older sites. There may be no discernable price differential before a site is discovered and clean-up actions begin. At this point, property values may show a sharp decline as public awareness and fear grow. This price decline could in turn be followed by a price change back to the prediscovery period if land buyers and sellers think that the clean-up actions successfully alleviated the risks. While this three stage process is admittedly oversimplified, it does suggest that possible differences between short-run and long-run impacts should be accounted for in compensation schemes. It also suggests that the choice of time periods for property value analysis should be carefully considered.

C. The Relationship Between Distance and Property Values

If property values are in fact affected by the risks associated with hazardous waste sites, one might assume that a gradient of price effects would emerge based on the distance of the property from the site. Of course, distance alone may not be an adequate measure of risk from a given site. The direction of prevailing winds and underground movement of water in aquifers also should be considered. Nonetheless, distance alone may be a useful proxy for risk. A cross-sectional regression of property values on distance from a site, housing and neighborhood characteristics, environmental parameters not related to the site, income and other locational attributes could isolate the existence of a property value gradient.

It has already been noted that such a measure would provide only a rough measure of benefits. In addition, the site or sites selected for such an analysis and the risks associated with the site would have to be well publicized to ensure informed market participants. Finally, it is important to ensure an adequate number of observations that the site abuts or affects residental properties. This may limit the number of available cases, since many sites are located in industrial or rural areas.[1] Property values in such areas could not be expected to reflect benefits

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[1] For example, of 21 proposed or current facilities studied in an EPA report, 10 were located in rural areas, 6 in urban and 5 in suburban locations. The adjacent land use for the facilities was mostly industrial (8) and agricultural (6).

nearly as well as in residential areas; low turnover and improvements would make industrial property prices unsuitable for analysis, and unless agricultural productivity is affected, there may be no mechanism to internalize consumer effects on the price of agricultural land.

It may also be possible to expand this analysis to study the variation in rent gradients between an unsafe site and a site that meets federal or state regulatory requirements. Everything else being equal, one would expect less of a depressing effect on property values at a given distance for the safe site relative to an unsafe site. For example, Figure 1 shows hypothetical rent gradients for two sites, one considered unsafe (I) and the other relatively safe (II). Prices are depressed relative to surrounding

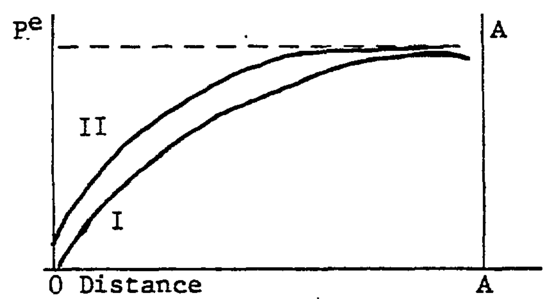

Figure 1

equilibrium values up to some distance A where the effect becomes indistinguishable from zero. The specific functional form for the distance effect would be established empirically. Although the difference between the curves will depend on the information available to buyers and sellers of land near the sites, the results could prove useful in answering the questions posed in the introduction of this Appendix: the value placed on remedial action to bring sites into compliance with current regulations.

D. Time Series Analysis of Hazardous Waste Property Value Impacts

In the beginning of this paper the question was posed concerning the appropriate compensation for individuals exposed to disposal site risks. A time series study of property values before and after the siting of a disposal facility might be superior to a single cross-sectional equation in determining the economic damages that occur in facility siting. Under this approach, a recently established site meeting current safety standards would be chosen. One method would use a carefully specified cross-sectional equation showing the pre-siting price gradient and compare it with a post-siting gradient to show impacts at varying distances from the site. An alternative method would be to generate a price index and attribute changes in the index at the time the facility was sited to that decision. This latter approach must still confront the problem of measuring variation in effects as a function of distance from the facility.

V. SUMMARY/CONCLUSION

The principal purpose of this Appendix was to outline the major theoretical and empirical literature on property value studies. In doing so, we have focused on some of the more important uncertainties and limitations resulting from the required assumptions and data constraints that will affect application of this technique to hazardous waste sites. There are three significant conclusions. First, it appears that the hedonic approach offers a potentially useful tool for assessing the property value effects of hazardous waste sites. Second, the theoretical and empirical concerns with the hedonic approach to benefits estimation suggests strongly that the estimation of price effects may be all that is realistically possible. Third, the paucity of information of hazardous waste site characteristics limits the researchers' ability to define a quality or contamination variable for the property value equation and that a distance variable, along with perhaps dummy variables for contaminated private wells, may be the best that will be available.

Given these conclusions, the remaining sections of this report describe empirical tests of the hypothesis that hazardous waste sites have a depressing effect on nearby residential property values. The tests will follow the general design set forth below. While the model formulations focus almost entirely on price effects, they may provide useful information on the compensation questions discussed in the introduction of Appendix A. The models outlined here are not envisioned as the final word, but represent an initial attempt to determine the usefulness and applicability of property value studies for guiding hazardous waste regulatory decisions.

A. A Cross-sectional Study of a Site Known to be the Cause of Damages to Health and the Environment

The purpose of this analysis would be to establish the existence of a property value gradient based on distance from a site. To the extent the estimated equation is able to isolate a relationship between distance from the site and increased property values, it may offer a useful tool for assessing the potential damages resulting from hazardous wastes sites and for determining the appropriate locational characteristics of a site. Three caveats should be mentioned. First, no attempt will be made to translate these effects, if any, into anything more than a crude measure of lost benefits. Additional methodological research must be conducted before a better measure of benefits can be developed. Second, it will not be possible, in any formal way, to determine what type of damages (i.e., acute versus chronic health effects) are captured in the estimates. This would require survey data on the risk perceptions of participants in the land markets around a site. Third, it is possible that the effect of distance from a site will be related to distance from other disamenties. Further, the existence of contamination (say of groundwater supplies) may be unrelated to distance. In these cases, the regression results may be confused and provide misleading conclusions. Overcoming this problem requires careful site selection, data collection, and model specification.

B. A Cross-sectional/Time-series Study of a New Site

In this analysis, two cross-sectional equations would be estimated: one before a hazardous waste facility was sited and one after in an attempt to identify the effect of the facility on land values in the vicinity. This might be shown as a change in the property value gradient as a result of the site or the existence of a gradient where none had existed before. If this study is successful, it could be extended to other sites and used to determine the compensation payments needed to offset the disamenities associated with a site. Moreover, comparison of results from the two studies should help reveal information on the value of remedial action to reduce risks.

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APPENDIX B

Site Selection Criteria and Application

by

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Preface

Appendix B reviews the site selection process and describes the criteria employed for choosing sites. The focus is on those criteria which were not described in detail in Chapter III in the main body of the report. Also described are the sites which were ultimately chosen for the purpose of this study, as well as some of those which were not.

I. CRITERIA FOR INITIAL SITE SELECTION

A. Introduction

Two sets of criteria were employed in the initial site selection. The first set pertains to potential sample size and the existence of a continuous development around a site for use as a control. The fulfillment of these criteria is considered essential to an empirical investigation of hazardous waste sites. The second set of criteria is concerned with the different types of problems associated with hazardous waste sites, the extent to which these problems have been ameliorated and difficulties associated with measuring the affects of hazardous waste sites on property values. Non-fulfillment of the second set of criteria may affect empirical measurement, but does not necessarily preclude sites from consideration.

B. Sample Size

It is necessary to obtain a sufficient number of observations to study the effects of a hazardous waste site. The size of a potential sample may be predicted by the size of the population or the number of homes in the vicinity of the site and the duration of public concern. A minimum of 1,000 homes or 4,000 people as well as a two year period of public concern was considered necessary to generate a sufficient number of housing sales samples.

but Andover apparently did not [illegible]!

The necessary degree of concern is difficult to measure; however, a number of local indicators are available. Maybe the most important indicators are the number of complaints received by the local health department and the manner in which these complaints are presented. When residents present their concerns to public officials in a systematic fashion, they are presumed to be somewhat knowledgeable about the extent of the damage and its implications. The absence of an organized protest group does not necessarily imply ignorance and does not automatically disqualify a site from consideration. It does suggest, however, that more weight should be given to the other selection criteria.

Another indicator of widespread public concern with the hazardous waste site is when area residents associate health impairments they experience to the hazardous waste site in their vicinity. These health impairments may be documented by local health departments or other public agencies, or they may be undocumented and based on neighborhood consensus. While documented health effects are of major concern to residents, undocumented effects cannot be ignored.

Where there is groundwater contamination, one additional potential indicator of public concern is the number of households who resort to using bottled water as reported by the health department. The use of bottled water as an alternative may be due to bad tasting water or "rotten egg" odors perceived by residents to be associated with the hazardous waste site.

Once it is established that residents are concerned about a site, it is necessary to determine the duration of their concern. Two years are generally regarded as sufficient. However, this number will vary with population density and the velocity in the housing market. Note that for initial site selection only minimal information on public concern is required (i.e., year that awareness began).

C. Control

In the absence of an ideal control area, a residential gradient that extends for at least a couple of miles from the site is also a necessary characteristic in the choice of a study site. The gradient is used as a control for comparing the impact of the hazardous waste site on property values at different distances.

A site is only selected for further investigation if it meets this first set of criteria.

D. <u>Type of Contamination</u>

There are esentially two major types of contamination. The first, which for a number of years has illicited widespread concern, is air pollution. This manifests itself in the form of noxious fumes and wind blown particles from fire and/or explosion. The second is groundwater contamination, the focus of this study.

surface water & soil contamination too.

Potential damages from hazardous waste include: ground and surface water contamination, air pollution and fire and explosion hazards. Since these hazards may impact on property values differently, efforts were made to select a representative sample of the damages (scenarios).

The impact on property values of health threatening groundwater contamination is likely to depend on the availability of alternative potable water supplies. Three alternatives are considered:

- <u>No municipal water is available to residents with contaminated wells</u>. This may occur when there is no municipal water nearby or the hookup costs are prohibitive. Residents may be able to drill their own contaminated wells deeper to an uncontaminated aquifer, but again the cost may be prohibitive. (Additionally, deeper drillng may not be allowed for fear it will contaminate the lower aquifer.)
- <u>Municipal water is available to homes with contaminated well water</u>. The availability of municipal water is likely to

dampen the impact that groundwater contamination has on property values. This impact is likely to be further reduced if there is a short lag time between the discovery of contaminated wells and attachment to municipal water.

- Groundwater contamination, while widespread, poses no threat to resident's potable water because all homes are attatched to a safe supply of municipal drinking water. Hazardous waste sites with this scenario provide useful information on the non-drinking water effects of groundwater contamination.

Since a necessary requirement is that a large community be aware of the hazardous waste, sites responsible for surface water contamination only have been excluded. While the environmental impact of surface water is considerable, the measurable impact on property values is likely to be confined to those few properties in the immediate vicinity of the spill.

E. Remedial Action

The degree and speed of remedial action will most likely influence residents' perception of the health hazards and may, therefore, affect the likely property value impacts.[1] If clean up begins soon after the contamination is discovered and this clean up is anticipated to be thorough, then the impact on property values may be minimized. For example, existing home owners who would not consider selling their houses, were it not for contamination, may initially refrain from selling their homes because of anticipated, rapid remedial actions.

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[1] The options available to public officials range from immediate clean up (politically popular, but financially difficult) to superficial investigation (politically unpopular, but often financially necessary).

It stands to reason that larger property value impacts are anticipated, when the clean-up efforts are incomplete.

A hazardous waste site where remedial action was rapid and complete would, therefore, lack the after effect necessary for a study of this nature. Throughout our investigation, we encountered no site with remedial action of the extent that would warrant preclusion solely on that basis.

Speculators, for other reasons, may withhold real estate from the market if they suspect that remedial action will effectively increase land values above their pre-contamination levels. This could occur where extensive clean up removed other environmental disamenties that were previously depressing property values. In such a case the site was rejected since it was believed that meaningful evaluation of the changes between the pre- and post-contamination periods was not possible.

F. Industrial Interference

Nearby industrial plants, landfills, and other hazardous waste sites tend to share common nuisance characteristics with a study site, thereby making it diffficult to isolate their individual impacts on property values. These sites were not considered optimal for the purpose of this study.

II. MODEL HAZARDOUS WASTE PROCESSING FACILITIES

A. Criteria for Initial Model Site Selection

One possible method for estimating the benefits realized from conformance to existing regulations would be to calculate the difference in property value effects between a site which is in conformance with existing regulations (model site) and one that is not. Preliminary investigations were undertaken to identify such "model" sites.

The ones which were identified (Table 1) did not, however, conform to the other standard requirements of site selection, i.e., adequate sample size, residential gradient and minimal interference from industrial plants, landfills and hazardous waste dumps. As a result, the method for estimating benefits was rendered ineffective.

B. Model Site Search Sources

Six potential model hazardous waste processing facilities were suggested by the U.S. Environmental Protection Agency.

A number of model sites were also suggested by Robert Pojasek who is an economist with Weston, Inc. Currently, he is working on a contract with the Ontario Waste Management Authority to develop a government-run waste management program. As a result, he is extremely knowledgeable about model hazardous waste processing facilities.

TABLE 1: MODEL SITES

UNUSED, BUT RESEARCHED MODEL SITES	POTENTIAL SAMPLE SIZE (In Homes Or Population)	WATER SUPPLIES	EXTENT OF CONTAMINATION	PUBLIC AWARENESS AND CONCERN	COMMENTS
I.V. Conversions Marcus Hook, PA	9,880 people (3573 homes) w/in 1 mi. 40,117 people (14,906 homes) w/in 3 mi. Highly industrial.	100% municipal water.	No documented groundwater contamination.	Operations began Jan. 1980. Public concern is very limited.	Nearby waste treatment facility has had odor problems.
Envio-Safe Services 1) Grandview, ID 2) Bruneau, ID	Open range land, sparsely populated.	100% private wells.	No documented groundwater contamination.	Grandview site began operating in 1973 and Bruneau site began 1980. Sporadic public protest.	Area residents don't like the fact that most chemicals are from out of state.
Chemical Waste Management Emmelle, AL	Sparsely populated <10 homes w/in 1 mile <500 people w/in 5 mi.	Private wells & Municipal water.	No documented groundwater contamination. Some odor problems.	Operations began in August 1977. Most complaints center on transportation of waste through community.	
U.S. Ecology Sheffield, IL	Sparsely populated 20 homes w/in 1 mi 500 people w/in 3-5 miles.		No documented groundwater contamination. Surface water contaminmation has resulted in a minor fish kill.	Opened in 1967 for radioactive wastes & 1974 for chemical wastes. Organized public protest.	
IT Corporation Martinez, CA	1,800 people w/in 1 m. 50,000 people w/in 3 mi. Highly industrial.	100% municipal water.	Groundwater contamination is of minor concern because high saline content makes it unpotable.	Operations began in 1951. Numerous complaints about foul ordors. Problem corrected in 1980.	Two landfills located nearby. It is difficult for health officials to determine origin of some complaints.
SCA Braintree, MA	10,000 people w/in 1 mi. 60,000 people w/in 3 mi. Highly industrial.	100% municipal water.	Air pollution (fire).	Operations began around 1974, but residents were unaware of the site until a fire in 1978. Major public protest right after the fire but it did not last long.	

III. PRELIMINARY FIELD TRIP

The waste dump in Pleasant Plains, Dover Township, New Jersey, was selected for a site visit and preliminary investigation into the effects of hazardous waste sites on housing values. This task was undertaken at a potential study site in order to:

- ascertain the feasibility of such a cross-sectional study;
- identify some of the problems likely to be incurred in the availability and collection of housing data, and more informal information gathering; and
- to determine in a general fashion what the response to the potential hazard is likely to have on housing values.

A more specific purpose was to ascertain the problems involved in undertaking an analysis of the immediate, as well as the long-term, impacts of hazardous waste.

IV. SITE VISITS AND FINAL SCREENINGS

In order to conduct final screenings and where possible collect property value data, five of the most promising sites were visited. These are:

- Lehigh Electric and Engineering Company and Iacavazzi Landfill, Old Forge, Pennsylvania (one site);
- Lipari Landfill, Pitman, New Jersey;
- Chemical Control, Elizabeth, New Jersey;
- Pleasant Plains pump Site, Pleasant Plains, New Jersey and the
- Andover Sites, Andover, Minnesota.

Sites were selected on the basis of the criteria outlined in Section I of this Appendix where population or number of homes near each site and the duration of public awareness of the contamination were considered sufficient to generate a significant number of house sales. According to local indicators, e.g., citizens' complaints to the health department, chemical contamination was severe enough to involve a large percentage of the community. Lastly, each site offered one of the different contamination scenarios: groundwater contamination with and without available municipal water. Table 2 summarizes this background information for each site.

Though five sites were visited, property data were collected only for the sites in Pleasant Plains, Andover and Elizabeth. Housing data for the three remaining sites were either inadequate or inaccessible. Each site visit is discussed below.

TABLE 2: SITES SELECTED FOR FINAL SCREENINGS AND VISITS

SITES	POPULATION	TYPE OF CONTAMINATION; ALL ARE HAZARDOUS WASTES	DEGREE OF CONTAMINATION	PUBLIC AWARENESS	CONTAINMENT AND REMEDY PLANS
Lehigh Electric & Engineering Co.* Old Forge, PA	500 homes w/in 1/4 m. 2,000-3,000 homes w/in 1 m. Suburban.	Groundwater and wind blown PCBs.	PCB dust is spread throughout the community by wind, car tires and people walking through the site. All use city water.	Complaints lodged by well-organized community groups. Some area residents have elevated levels of PCB in their blood. Facility began operating in 1920's; public became aware May, 1981. Closed March 1981.	The site has been "securely" fenced." EPA is investigating for remedial action.
Iacavazzi Landfill,* Old Forge, PA	300-500 homes w/in 1/4 m. Community of 10-20,000 nearby. Suburban.	Noxious fumes, groundwater.	Possible ground water cont. Noxious fumes. Almost all residents use municipal water.	Complaints lodged by organized community groups. Public concern began in late 1979. Some residents use bottled water.	Unknown.
Lipari Landfill Pitman, NJ	800-900 people w/in 1/4 m. 10,000 people w/in 1 m. Surburban.	Groundwater, Surface Water, Air Pollution.	Groundwater cont. Has spread from the 7 acre landfill to an additional 9 acres. Almost all residents use municipal H20.	Numerous property tax appeals. Community is concerned but no known organized groups involved. Public awareness began in early 1970s.	EPA is investigating for remedial action.
Chemical Control, Elizabeth, NJ	100,000 w/in 1/4 mi. continous pop. Urban/ industrial.	Groundwater and air pollution; Threat of fire and explosion.	Documented ground water and surface water cont. Major explosions and fire All use city water.	Complaints have been minimal and unorganized. No ~~none~~ documented or undocumented health effects. Danger was presented in 1975 but public concern did not begin until 1979, with natl' coverage of incident.	Extensive 2 1/2 year clean up program completed May have increased land values.
Hazardous Waste Dump, Pleasant Plains, NJ	5,000 residents within 1/2 m. Suburban.	Groundwater.	161 private wells closed.	Extensive coverage by local papers-Widespread awareness and concern began in 1974- Dumping took place in 1971 Extensive use of bottled water.	Residents provided w/interm water supply. Barrels + soil removed-Municipal water hook up for cont. wells.
Andover Sites, Andover, MN	300 residents w/in 1/4 mi. 13,500 w/in 2 m.	Groundwater.	Cont. of test wells & 2 private wells. Def. spreading. 50% have private wells.	Request for property assesment reevaluation. Public awareness began in 1979.	EPA is investigating for remedial action. Some barrels have been removed by owner. Hook-up to city water is prohibitively expensive.

*One site.

A. Pleasant Plains, New Jersey, Hazardous Waste Dump

Pleasant Plains, located in Dover Township, New Jersey, was one of the two sites chosen for studying the impact of hazardous waste on residential property values. Preliminary investigation suggested, and a site visit confirmed, that the Dover site met all the criteria outlined in Section I of this Appendix. The residential population and the extent and duration of concern were considered to be of the magnitude which would produce a sufficient sample of housing sales, and there was no indication that the remedial action undertaken would interfere with the study. The Dover Township Landfill, which is located 2 miles from the waste dump, could, however, be a source of interference.

A brief history and litigation settlements are given below.[2,3]

During March to December 1971, 5,000 to 6,000 barrels of chemical wastes from a Union Carbide plant in Bound Brook, New Jersey, were illegally dumped on a parcel of farm land in Pleasant Plains, Dover Township, New Jersey, and in the township landfill. The wastes included aromatic hydrocarbons, benzene, toluene, styrene, xylene, ketones, alcohols and phenolic resins.

In January 1972, the Superior Court of New Jersey ordered Union Carbide Corporation to remove and properly dispose of the hazardous wastes. By April 1972, all of the known wastes had been removed.

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[2] U.S. Congress, Senate Committee on Environment and Public Works. Six Case Studies of Compensation for Toxic Substances Pollution: Alabama, California, Michigan, Missouri, New Jersey, Texas. Serial No. 96-13, 96th Congress, 2nd Session, (Washington, D.C.: Government Printing Office, 1980), pp. 339-340.

[3] U.S. Environmental Protection Agency, Office of Solid Waste Management Programs, Final Report--Analysis of a Land Disposal Damage Incident Involving Hazardous Waste Materials, Dover Township, New Jersey, by M. Ghassemi, (Redondo Beach, CA: TRW systems Group, May 1976), p. 37.

Groundwater contamination was first discovered in early 1974, when residents began complaining about an unusual taste and odor from their well water. Chemical analysis of the well water revealed high levels of organic compounds. Though the tests were limited in their ability to characterize the contaminants, phenol, styrene and toluene were discovered.

In September 1974, 148 wells in the contaminated area were condemned by the Dover Township Board of Health and ordered sealed at the owners' expense. Residents were provided with an interim water supply until November 1974, when the municipal water system was extended to the area.

In 1976, additional groundwater contamination was discoverd in Pleasant Plains, and in 1982, it was discovered in the nearby town of Silverton. Municipal water was extended to both of these areas.

The State of New Jersey and Pleasant Plains residents sued Union Carbide for compensation. When the case was settled, residents with contaminated wells received $1,000 each and the state received $60,000 for the costs it incurred.

1. Background

According to the Census Bureau data, the population of Pleasant Plains in 1980 was 5,600.[4] Pleasant Plains is a residential community of well kept, single family homes and is one of several housing developments which emerged during the 1970s, as part of the north/south expansion of Tom's River, (the major commercial center of Dover Township).

Relative to the pre-development period, most residences are now located in housing developments as opposed to individual tracts of land.

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[4] U.S. Department of Commerce, Bureau of the Census, 1980 Census of Population and Housing, Block Statistics Reports PHC 80-1 (Washington, D.C.: U.S. Government Printing Office, 1982).

More recently, (late 1970s) development has taken the form of individual buyers building custom-built homes. Some of these latter homes are reported to cost up to $500,000. This and other anecdotal evidence suggest that Pleasant Plains has evolved into a middle and upper class residential area.

Virtually the entire population of Pleasant Plains is located within the zone designated by the New Jersey Department of Environmental Protection (DEP) in 1974 as either contaminated (Zone 1) or questionable (Zone II). The rest of the Pleasant Plains area was concluded to be uncontaminated and was designated as Zone III. (See Map II, Appendix C.)

2. Sample Size

Early investigation suggested that, based on the size of the population and the duration and extent of residents' concern for the waste dump, a sufficient sample of housing sales was available for a property value study of Pleasant Plains. Initial estimates from the Dover Township Department of Planning placed the population within 1/2 mile from the waste site at 5,500.[5] Even though the actual population for this distance was considerably less, a substantial number of useful housing sales were available to make this a feasible study site.

Widespread awareness of the contamination episodes was ensured by local newspapers which reported extensively on the hazardous waste site and accompanying groundwater contamination. Pleasant Plains' residents initially became aware of groundwater contamination in January 1974, after 3 wells were found to be contaminated. Soon after, 140 additional wells were

[5] Comparison with the data from the Census Bureau revealed that this figure was misleading and that 5,500 is the approximate population for the entire town of Pleasant Plains.

found to be affected resulting in the condemnation of 143 wells. Well contamination continued to be a problem with new contamination being discovered in 1976 and 1982, in Pleasant Plains and Silverton, respectively.

3. Control

A residential community extends for approximately 2 miles from the waste site and serves as a control for comparing the impact of hazardous waste on properties at various distances.

4. Remedial Action

Concern for the hazards of the dump on the part of Pleasant Plains residents has changed over the years in response to the remedial action that occurred. Remedial action began in 1972, with the removal of the waste from the dump. However, during this time and prior to the discovery of the contaminated wells in 1974, few residents perceived the health hazards associated with the site.

After 1974, however, residents perceived the site in an entirely different manner and two major concerns began to surface: health hazards and impact on property values.[6]

Even though health effects could not be confirmed by the health department, chemicals in the well were known to be toxic and an alternative source of water was considered a necessary precaution.

Plans were shortly developed to extend the municipal water system to the homes with condemned wells. In the interim, residences were supplied with alternate sources of potable water, e.g., fire hydrants, National Guard water tanks. Once the homes with condemned wells were attached

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[6] Op. cit., M. Ghassemi.

to municipal water, residents' concern for the health hazard seemed to fall considerably.

According to **realtors**[7] in the area, concerns about ~~like~~ health **effects** and ~~about~~ property values virtually disappeared as soon as affected homes were connected to the municipal water system. They indicated that initially there was some difficulty selling the homes with contaminated wells, but this problem only lasted until municipal water became available.

It is not a foregone conclusion that the delay in sale was due **to** contamination, however, since it is the case that mortgages are not available for homes that lack a potable water **supply.**[8] So it was unknown whether prospective buyers who did not wish to see homes with contaminated wells did so because of the mortgage question or the health **hazard.**[9] reword

Renewed concerns emerged in 1976, when 13 new wells were found to be contaminated. This was short lived, however, because the affected homes were quickly attached to municipal water.

5. Interference

Some groundwater contamination may have originated from a source other than the dump, namely, the Dover Township Landfill. (See Map I, Appendix C.) By 1976, monitoring results on the contaminated wells in Pleasant Plains revealed that some of the more highly contaminated ones

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[7]**Three** realtors who serve the Pleasant Plains area were interviewed in April 1982, for their impression on the impact of the waste dump on property values. These interviews tend to confirm the impressions of the realtors interviewed for an EPA report. on the Dover waste dumping incident that were conducted in May 1976.

[8]**Brian** Flanagan (Brian J. Flanagan Real Estate).

[9]**Kay** Weschler (Crossroads Realty).

are located closer to the landfill than to the waste site. However, hydrologists with the New Jersey Department of Environmental Protection reported that the landfill is an unlikely source because of the direction of groundwater flow. Nothing further can be said on this facility since a complete analysis of the groundwater flow has not yet been completed.

B. Andover, Minnesota, Hazardous Waste Sites[10]

Preliminary investigation suggested that the hazardous waste dumps and processing facility located in Andover, Minnesota, would be an appropriate study site. Like Elizabeth and Pleasant Plains, this site met all the criteria discussed in Section I.

This site was of particular interest because it offered a unique scenario where the contamination impacted a neighborhood which is served by wells and for which there is no alternative supply of municipal water. Unlike Pleasant Plains, some difficulty was encountered with the county assessment office. Consequently, not all of the information on the property record card was available for the study.

1. Background

The Andover sites are a group of five industrial properties located on 40 acres in Andover, Minnesota, approximately 20 miles north of Minneapolis. The sites received in excess of 1,000 barrels of waste solvents, paints, inks, glues and grease between 1970 and 1973. Originally, the operators of these sites were reclaiming solvents by separation

[10]Information on this site was provided in part by Gorden Starkey, Anoka County Assessment Department; Tim Yantoz, Assistant Administrator, Anoka County; Jon Christensen, Health Officer, Anoka County Health Department, Anoka County Court House, Anoka, MN; U.S. Environmental Protection Agency, Hazardous Site Control Division, Office of Emergency and Remedial Response, Andover Sites: Interim Priority List (Superfund List), October 23, 1981.

and then burying the residual sludges in unlined pits. Some solvents were disposed of by burning them in open pits. Before the contamination was discovered, this 40 acre site was considered to be only a junkyard.

In 1973, the Minnesota Pollution Control Agency (MPCA) and Anoka County officials requested the owner/operator of the hazardous waste processing facility to cease operations and begin cleanup of the chemicals stored on the site. This request and many follow up requests were ignored.

In 1975, contamination was discovered in one of the wells located on the property. Public officials' requests for clean up continued to be ignored by the site operators. Groundwater contamination was reconfirmed in April 1980, when one well on the site and two wells on the edge of the site were found to be contaminiated with unsafe levels of arsenic, cadmium, phenols, methyl chloride, benzine (a suspected carcinogen) and toluene (a confirmed carcinogen). The EPA installed 24 monitoring wells on the hazardous waste site and confirmed the contamination of near-surface groundwater contamination by metals and organic compounds.

Test results show that a shallow aquifer of about 50 feet has been contaminated. The plume is spreading four to eight feet a year in south, southwest and northwest directions (as indicated by a water contour map) toward well populated areas. Approxiamtely 10% of the private wells in the area are connected to this shallow aquifer. It has not yet been determined if deeper aquifers are affected. EPA has recently completed testing of deeper aquifers, but these results are not yet available.

The impressions of MPCA field personnel and assessors for the area are that property values have not been affected. However, it is their belief that if deep aquifers are found to be contaminated, property values will be significantly affected.

In response to these results and the continued reluctance of the owners to clean up the sites, the Anoka County Board, in December 1980, decided to begin cleaning up the sites with the intention of collecting the cost at a later date. In October 1980, the MPCA initiated litigation against the owners for failure to clean up the hazardous wastes and for the costs of remedial action.

The area is comprised generally of single family homes and is predominantly white middle class. The homes, for most part, are well kept and are situated on lots of approximately one quarter acre in residential developments.

2. Sample Size

The number of residents in the area combined with the length of their awareness was considered sufficient to provide a significant number of observations.

The Andover hazardous waste site is located in a well populated suburban area. According to the local planning department, within 1/2 mile of the site there are approximately 300 residents and within 2 miles there are approximately 13,500 residents. According to local officials, residents became seriously concerned about the site in early 1979, when the MPCA realized that the problem was more than they could handle and solicited assistance from the NEPA. It was at this point that residents began to request property re-evaluations from the tax assessor's office,[11] and locally organized citizen groups began to apply pressure to local officials.

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[11] These requests were denied.

3. Control

In terms of a control, residential development is continuous for about 4 miles in all directions from the waste site.

4. Remedial Action

Remedial action at the Andover sites has taken the form of discreet removal of several of the barrels by the property owner. However, as late as December 1981, several barrels were still on the property.

5. Interference

Approximately one mile north of the waste site is a landfill operated by a statewide waste disposal company. Preliminary investigation did not reveal the presence of hazardous waste here. Therefore, this facility, even though incorporated into the study, was viewed as a different type of environmental disamenity.[12] No large industrial areas or known waste sites exist nearby.

C. Elizabeth, New Jersey, Chemical Control[13]

Based on preliminary investigation the defunct Chemical Control hazardous waste processing and storage facility appeared to fulfill most of the criteria outlined above: a large urban residential population, well informed residents, prolonged concern and possibly non-interfering factors. Upon visiting the tax assessor's office in Elizabeth, however,

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[12] It was recently discovered that the landfill has a pit where toxic waste was once buried. The asphalt lining is now eroding and there is a fear that this is a potentially bigger problem than the waste dump.

[13] Preliminary information on this site was provied in part by: George Ring, Principal Environmental Engineer, Bureau of Abandoned Sites, New Jersey Department of Environmental Protection; John Surmay, Director, Health, Welfare and Housing, City of Elizabeth, New Jersey; U.S. Environmental Protection Agency, Hazardous Site Control Division, Office of Emergency and Remedial Response, Chemical Control: Interim Priority List (Superfund List), October 23, 1981.

it was decided to reject Chemical Control as a study site primarily due to the difficulty in obtaining the property record data.

1. Background

The Chemical Control site is located on the outskirts of the City of Elizabeth and began operating in 1970. It is bordered on two sides by industrial plants, one side by the Arthur Kill (a river) and the other by a residential area. Within 1/4 of a mile there is a continuous residential population of approximately 100,000. Most of the residences are single family homes in fair to poor condition situated on 1/8 acre lots. A number of these homes were boarded shut. There are also some three story apartments which appear to be in poor condition; a few are burned out. The area supports a fair number of small businesses, most of which are located along a fairly active commercial strip. Bordering the residential community on two sides are numerous chemical and petro-chemical plants.

Air pollution, fire and explosion seem to be the major cause for concern. According to local officials, as early as 1971, Chemical Control was violating state and local air quality standards. Groundwater contamination has also occured, but since all area residents are attached to municipal water, this was not considered to be the major issue. (There is some reason to believe that Chemical Control may not be solely responsible for the groundwater contamination.)

2. Sample Size

The residential population and the extent and duration of their concern were considered to be of the magnitude which would produce a sufficient sample of housing sales.

Area residents did not become seriously concerned about the site until January 1979, according to John Surmay, Director of the city's Health, Welfare and Housing Department. The site was brought to their attention through the combined efforts of the City to impose stricter operating procedures on Chemical Control and the national media's focus on Love Canal. Mr. Surmay believed that a serious threat existed as early as 1975, but until 1979, complaints were infrequent.

The residents' lack of concern for the site, before 1979, seems more reasonable if the site's history is considered. Before Chemical Control began processing hazardous waste, it served as a storage facility for barrels. Therefore, in 1971, when the company began processing hazardous wastes which are frequently transferred in barrels, there was little visual change in its operations. Addition&y, the chemical odors that are associated with the processing of hazardous wastes may have been hard to differentiate from the odors emitted from chemical plants that had been operating in the area for years. January 1979 was therefore accepted as the date for widespread public concern of the hazards posed by the Chemical Control site.

3. <u>Control</u>

Beyond one quarter mile of the site, there is a continuous, densely populated area for use as a control.

4. <u>Remedial Action</u>

As early as 1971, Elizabeth City, health officials considered the air pollution from Chemical Control and its general operating procedure as hazardous to residents and workers near the site. The city's efforts were unsuccessful until March 1978, when the Bureau of Solid Waste

Administration of New Jersey issued an administrative order requiring Chemical Control to correct several major violations. When this failed to rectify the problem, the Superior Court of New Jersey, in February 1978, placed the site in receivership. The New Jersey Department of Environmental Protection then began clean-up operations.

As clean-up operations commenced, the severity of the situation became apparent, prompting the Mayor of Elizabeth to declare a four-week state of emergency beginning May 3, 1979. Before the clean up was completed in April 1980, a fire and a series of explosions occured at the site. Residents were forced to evacuate their homes and a number of firemen were hospitalized. Clean up continued after the fire, and, according to local assessors, the clean up has had a positive impact on land values.

5. Industrial Interference

The nearby industrial plants may have shared common nuisance characteristics with the study site thereby making it difficult to isolate their impacts on residential property values. This site posed potential problems with regard to separating the individual effects of the various disamenities.

6. Data Collection

Several factors including a large population and widespread contamination suggested that Elizabeth would have been a most interesting and potentially valuable study site. A site visit was made after which a deliberate effort was made to begin collecting the data from the assessor's office. The "before" contamination years were chosen as 1973-1975, and the "after" years were 1979-1981. Given the high population concentration, observations were limited to within 1 mile of the Chemical Control site. Two residential areas were excluded because one was being redeveloped by the city and the other area was heavily industrialized.

Unfortunately, the assessors who had previously agreed to our investigation denied us general as well as the more direct assistance needed to interpret the property record cards. Moreover, unlike the Pleasant Plains office, a photo copying machine was not available and as a result the data had to be copied by hand. (It was similar to reading a road map without a legend.)

A follow up visit to Elizabeth to gather the missing data was not considered worthwhile for a number of different reasons:

- Further investigation of the study site revealed that the housing market was dissected to reflect the ethnic diversity of the area.
- Cleanup, because it continued over a number of years, is likely to continually change the residents' perception of the danger making it difficult to assess the impact on property values. In this case, there is no real demarcation between the periods "before" and "after" contamination.
- Finally, there was no indication that the assessor's office would have been more cooperative with a follow up visit.

D. Lehigh Electric and Engineering Company, Iacavazzi Landfill, Old Forge, Pennsylvania[14]

Preliminary investigation suggested that the Lehigh Electric and Engineering Company and the Iacavazzi Landfill would be appropriate hazardous waste sites. These two sites, located within 1/2 mile of each other; are close enough to be considered one site. Together, they met all of the criteria outlined in Section 1: a large suburban population, area residents are well informed about the presence of hazardous wastes and the sites should have existed long enough to allow a sufficient number of house sales to occur. However, upon visiting the tax assessor's office in Scranton and surveying the property record cards, it was decided that these sites would not be appropriate for our study, because the residential areas surrounding the site generated an insufficient number of usable housing sales.

1. Background

The Lehigh Electric and Engineering Company and the Iacavazzi Landfill are located in Old Forge, Pennsylvania, southwest of Scranton. The former is an inactive hazardous waste processing facility which was operated from the mid-1920s until March 1981. The Iacavazzi Landfill, located 1/2 mile from the Lehigh facility, was designed to receive municipal waste, but was also used illegally as a dumping ground for hazardous industrial wastes. This facility operated from 1973 to 1978.

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[14]Preliminary information was provided by Dave Lamereaux, Environmental Engineer, Lackawanna County Health Department, Pennsylvania, telephone (717) 826-2109; County Board of Assessors, Pennsylvania, telephone (717) 961-6728; U.S. Environmental Protection Agency, Hazardous Site Control Division, Office of Emergency and Remedial Response, Lehigh Electric and Engineering Company: Interim Priority List (Superfund List), October 23, 1981.

The major type of contamination present at the Lehigh facility and the Iacavazzi landfill is air pollution, though traces of groundwater contamination have been discovered. The major contaminant stored on the Lehigh site are polychlorinated-biphenyl (PCB)-laden oils that are leaking from transformers and capacitors. The soil on the site is heavily contaminated with PCB's which are spreading across the community via wind blown dust, cars and people travelling across the site. Noxious fumes from the landfill also contribute to contamination. Due to ongoing litigation, the names of the hazardous chemicals dumped at the Iacavazzi Landfill have not been released.

Groundwater contamination has occured in the area of the Lehigh facility and the Iacavazzi landfill, but a direct link to these facilities has not been documented. However, all residents are connected to a safe supply of municipal water which would serve to mitigate the impact of groundwater contamination on property values.

2. Sample Size

The extent of public awareness and the number of residents near the sites (500 within 1/4 mile and 2,000-3,000 within 1 mile) should have been sufficient to generate more than our required number of sales. But a survey of the property record cards, in the tax assessor's office in Scranton, revealed only 24 useful sales within approximately 1/4 mile of the site over the years 1979 to 1981. Most of the sales that occured during these years were for lots without homes and were not useful to our study. Possibly contributing to the low number of sales was the severely depressed state of the housing market in this particular community for the past two years.

Area residents became concerned with the Lehigh site and Iacavazzi Landfill in May 1981 and late 1979, respectively. Public concern for the health hazards imposed by the sites is widespread. A well organized and widely supported citizens group has petitioned state and federal officials to take remedial action. Community action has been encouraged by medical tests which revealed elevated levels of PCB's in the blood of some residents,

According to an assessor in the Scranton office, a few residents have requested property re-evaluations, but they were denied. More homeowners would request re-evaluations, according to the assessor, but they are afraid that the assessed value of their homes would plummet as a result.

3. Control

Within one mile of the site, there is a continuous population of 3,000 which is the control factor.

4. Remedial Action

In the spring of 1981, remedial action began when the U.S. Environmental Protection Agency constructed a fence around the Lehigh site and posted a 24 hour guard. Plans for the removal of the PCB's and contaminated soils from this site were still being made in December 1981. A Resource Conservation and Recovery Act Section 7003 suit was filed against the Lehigh site owner/operator in April 1980. As of December 1981, no clean-up action had been taken at the Iacavazzi Landfill.

5. Interference

Located within 3 miles of these sites are two landfills. Local residents are, however, keeping a close watch on these landfills to ensure that proper operating procedures are followed. So far, no hazardous chemicals have been detected, nor do they seem to pose any immediate threat. These sites were, therefore, not relevant for our study.

As a result of an insufficient number of housing sales, the Old Forge, Pennsylvania, location was rejected as a study site.

E. Lipari Landfill, Pitman, New Jersey[15]

Initial investigation suggested that the Lipari Landfill would be an approprite study site. This site met all the criteria outlined earlier: there is a large suburban population nearby, area residents are well informed about the site and there has been a long period of public concern.

Upon visiting the Gloucester County tax Assessor's office, it was discovered that the property record cards were not accessible. Only residents had access to their own property record cards. Further, the record cards are stored in three different township offices, and each office is open for only 2 evening hours each week. (The Lipari Landfill is located in Montana Township and is adjacent to Pitman and Glassboro Townships.) As a result the Lipari Landfill was not feasible as a study site.

1. Background

The Lipari Landfill is located in Pitman, New Jersey, approximately 15 miles south of Camden. This inactive landfill was the dumping ground, from 1958 to 1971, for industrial and domestic waste, including methanol, benzene, toluene, xylene, isopropanol, butanol, bis (2-chloroethyl) ether, beryllium and mercury.

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[15]**Sources:** Bill Hinshillwood, Principal Sanitary Inspector, Gloucester County Health Department, NJ, telephone (609) 845-1600; Robert Dickson, Supervising Principal of Planning, Gloucester County Planning Department, NJ, telephone (609) 881-1200; U.S. Environmental Protection Agency, Hazardous Site Control Division, Office of Emergency and Remedial Response, Lipari Landfill, Interm Priority List (Superfund List), October 23, 1981.

Groundwater contamination, surface water contamination and air pollution are all problems at the Lipari Landfill. Hazardous chemicals have spread from the 7 acre landfill to an additional 9 acres. An aquifer that underlies the landfill has been contaminated, but the extent is unknown.

Like the Old Forge site, the impact of groundwater contamination on real estate is likely to be mitigated by the fact that almost all residents are connected to a safe supply of municipal water. Approximately 5% of the area residents use private wells. The residential area is characterized as suburban with modest single family homes on 1/4 acre lots.

2. Sample Size

The number of residents near the site and the length of their awareness would have likely produced a significant number of housing sales. There are 800-900 residents within 1/4 mile of the site and 10,000 within 1 mile, according to the Gloucester County Planning Department.

Residents became concerned with the site in the early 1970s. Their degree of concern was moderate, taking the form of numerous property tax appeals rather than organized protests.

3. Control

The residential area is continuous for a couple of miles from the site and would have served as a control for comparing the impact of the hazardous waste site on property values at various distances.

4. Remedial Action

Even though residents first became concerned with the site as far back as the early 1970s, remedial action at the Lipari Landfill has been minimal. The only actions to date, have been signs warning the public of the chemical dangers and the testing of groundwater. A number of remedial plans have been suggested, but none have been implemented. In March 1980, the U.S. EPA filed a Resource Conservation and Recovery Act suit against the owner/operator of the site.

5. Interference

There are no landfills or industries located near the Lipari Landfill that would have complicated a property value study.

F. Unusable Sites

Many of the investigated hazardous waste sites did not fulfill the criteria regarding sample size and were, therefore, not eligible for final screenings and visits. The second set of criteria also played a role but was less of a determining factor in eliminating sites. Table 3 lists the unusable sites and their important characteristics. The background information for some sites is incomplete. This occured when the investigation was aborted because early evidence (i.e., population size) suggested that a site was unusable.

1. Sample Size

Most of the unused hazardous waste sites are located in rural areas where the population concentration is low. As a result, the sample size, which is predicted by population, was not sufficient. Table 3, column "Potential Sample Size," reveals the number of sites with deficient sample size. Sample size was also deficient when the period of public concern was less than approximately two years which was the case with hazardous waste sites that had only recently been discovered. See the column "Public. Awareness and Date of Discovery." An example of this problem is the Davis Liquid Chemical Waste Disposal Site where contamination was discovered in June 1981.

Table 3: Unusable Sites

	Potential Sample Size				
SITES	POPULATION	PUBLIC AWARENESS & DATE OF DISCOVERY	EXTENT OF CONTAMINATION & THREAT TO DRINKING WATER	TYPE OF CONTAMINAITON	CORRECTIVE MEASURES
McAdoo Associates McAdoo, PA	500 people w/in 1 mi. 3,500 people w/in 1 1/2 mi.	Public seems satisfied with clean-up progress. Intial EPA investigation: 1979	No health complaints. Most people use municipal water.	Noxiuos fumes Surface Water Fire & Explosive hazard.	Site has been fenced and wastes are being removed
Gratiate County Landfill St. Louis, MI	4-5 homes w/in 1/4 mi. 100-150 homes w/in 1 mi. 4,000 people w/in 2 miles.	Residents are concerned, but no organized protest Discovered in 1977.	No wells contaminated but some private wells are threatened 95% of residents use municipal water.	Groundwater Surface water Air pollution	Site has been capped.
Ottati & Gross Kingston Steel Drum Kingston, NH	1,000 people w/in 1 mi.	Site discovered July 1979. Active citizens' group.	Only trace chemicals found in nearby wells. No municipal water available.	Groundwater Surface water	EPA began clean up operations in Spring '81
Keefe Environmental Services Epping, NH	500-1,000 people w/in 1 mi. 2,000-3,000 people w/in 5 mi.	Site discovered 1978-1979. Area residents are concerned.	3 wells cont. Residents were only advised to boil water 90% of area wells are threatened.	Groundwater Surface water Noxious fumes	EPA is containing spread of wastes.
Western Sand and Gravel Site Burrillville, RI	2,000 poeople w/in 1 mi.	Contamination discovered in 1979. Public involvement unknown.	Three private wells have been contaminated. People using bottled water.	Groundwater	Clean up has began.
Davis Liquid Chemical Waste Disposal Site Smithfield, RI		Contamination discovered June 1981	Some private wells contaminated, but still in use.	Groundwater Surface water	Source of contamination has not been established
Lone Pine Landfill Freehold Township, NJ	8-10 homes adjacent. 100 homes w/in 1/4 mi.	Initial EPA investigation was in 1980. Organized public protest.	Private wells show contamination below safety standard. Increases are expected. No municipal water available.	Groundwater	Unknown

Table 3 (continued): Unusable Sites

	Potential Sample Size					
SITES	POPULATION	PUBLIC AWARENESS & DATE OF DISCOVERY	EXTENT OF CONTAMINATION & THREAT TO DRINKING WATER	TYPE OF CONTAMINAITON	CORRECTIVE MEASURES	COMMENTS
Taylor Road Landfill Tampa, FL	Sparsely populated Rural	Problem discovered in early 1980.	Private wells cont. 180 families given bottled water.	Groundwater Explosive gas	Monitoring wells & gas vents installed; City water offered to 90 residences.	
Pickettville Road Landfill, Jacksonville, FL	Rural area w/light industry	No public outcry; Initial EPA investigation: 1981.	One well cont. No municipal water available.	Groundwater	Monitoring wells.	
Coleman-Evans Wood Preserving Co. Whitehouse, FL	12 families in affected areas		No wells cont.	Groundwater (sole source acquifer); Surface water	Monitoring wells installed and surface run off contained.	
Broward County Solid Waste Disposal Facility, Davis, FL	50-75 residents in immediate area	Organized protest by area residents. Problem discovered in 1981.	Contamination detected in monitering wells. The plume is stable.	Groundwater (sole source acquifer)	Ongoing hydrological survey.	
Delaware Sand and Gravel, Llangollen Army Creek Landfills New Castle, DE	1,000 people w/in 1/4 mi. 10,000 w/in 1 mi.	Initial EPA investigation: 1974.	Some private wells cont. but connected to city water; 85% of area has city water.	Groundwater (2 large aquifers contaminated); Noxious fumes	Back pumping is containing plume.	
Price's Landfill Egg Harbor, NJ	24 w/in 1/4 mi. 5,000 people w/in 1 mi.	Vigorous protests by area residents. Date of discovery unknown.	All wells in immediate vicinity cont.(30 residents) City water being extended to these residents. All other residents use city water. Claims of ill health.	Groundwater	Unknown	Great deal of speculative land investment due to the close proximity of Atlantic City
Sea Coast Niagara Falls, NY	50 homes & trailer pk. of 200 homes w/in 1/4 mi.	Moderate public protest. Date of discovery unknown.	Residents claim ill health effects.	Noxious Fumes	Unknown	Residential development continues.
SCA Porter, NY	25 homes w/in 1/2 mi. 2,000 people w/in 1 1/2 mi.	Moderate public protest. Date of discovery unknown.	Many complaints about noxious fumes Ill health effects claims. No documented contamination of private wells, but many people use bottled water.	Noxious Fumes Groundwater	Unknown	Municipal water was recently found to be highly cont.

Table 3 (continued): Unusable Sites

SITES	POPULATION (Potential Sample Size)	PUBLIC AWARENESS & DATE OF DISCOVERY	EXTENT OF CONTAMINATION & THREAT TO DRINKING WATER	TYPE OF CONTAMINATION	CORRECTIVE MEASURES	COMMENTS
ABM-Wade Chester, PA	Densely populated; highly industrialized.	Active citizen's group. Initial EPA investigation: 1979. Extent of ground water cont. is unknown.	Undocumented health effects. All residents use municipal water.	Groundwater Surface water Noxious fumes	1/2 of the wastes removed.	Many of the row houses are unoccupied
Sylvester's Nashua, NH	2,000 people w/in 1 mi. 20-25,000 w/in 5 mi.	Contamination discovered in 1979. Limited public protest.	Several wells threatened. These homes converted to municipal water supplies. No wells have actually been contaminated.	Groundwater Surface water Noxious fumes	Extensive clean-up operations	Waste dump has discouraged development.
Kopper Gas & Coke Plant St. Paul, MN	Densely populated (residential)	The toxic wastes were identified in 1979, but complaints about the plant began long ago. No ill health effects documented.	Wells up to 1 mi. from site contaminated; all residents use municipal water.	Groundwater	1/2 of the wastes removed. Major efforts to contain plume.	It may be difficult to differentiate between the affects of plant operations & hazardous wastes
Chem-Dyne Corp. Hamilton, OH	400-500 people w/in 1/4 mi. 65,000 people w/in 6-8 mi.	Complaints began around 1974. Since cleanup began in 1979 complaints have decreased. Small area impacted by fumes.	Most complaints concern fumes. A standby municipal well is threatened. All residents use municipal water.	Groundwater Surface water Noxious fumes	1/2 of the wastes removed.	No wells contaminated
Love Canal Niagara Falls, NY	Residential	Extensive protest at both the local and national level.	Numerous homes abandoned or sold to government agencies. Health damage has been documented	Groundwater Surface water Noxious fumes	Extensive clean-up operations	A number of nearby wastes dumps makes it difficult to differentiate the impact of Love Canal on property values.
//////////////////	//////////////////	//////////////////	//////////////////	////////////	CORRECTIVE MEASURES	
Ellisville Area Sites, near Ellisville, MO	Large residential area nearby.	Very few citizen complaints. Problem discovered July 1980	10 shallow wells contaminated.	Groundwater Surface water	Removal of drums began in 1980.	

Hazardous waste sites were also rejected when they illicited little or no concern from area residents. As mentioned above, concern is determined, in part, by the number of complaints. Lack of complaints was generally an indication of minimal contamination and/or sparse population, as occurred at the Pickett Road Landfill. However, at the heavily populated Ellisville Area sites, the rapid removal of the contaminents probably contributed to the low number of complaints.

2. Remedial Action

Remedial action, if complete, could shorten the period of concern below the designated two years. At the Delaware Sand and Gravel Landfill and the Llangollen Army Creek Landfill, a number of private wells were contaminated, but the residents were quickly attached to the municipal water systems. In addition, back-pumping wells were dug on the landfills to contain the contamination plume. Early remedial action, along with other factors, rendered this site ineffectual.

3. Interference

The Koppers Gas and Coke Plant and the Love Canal hazardous waste sites were rejected because of their proximity to industrial plants, landfills and/or other hazardous waste sites. The latter facilities share similar characteristics with the potential study sites, i.e., they are also sources of pollution, making it difficult to differentiate the individual impacts on property values.

Hazardous Waste Site Search Sources

The initial list of potential hazardous waste study sites was developed from the following **sources:**[16]

1. Top-Priority Superfund Sites EPA: The Superfund list contains the location and a brief description of EPA's top-priority hazardous waste sites. Originally the list was comprised of 282 sites, but was reduced by EPA to represent the 114 sites that posed the greatest threat to human health.

2. Six Case Studies of Compensation for Toxic Substances Pollution U.S. Senate Committee on Environment and Public Works: This report analyzes the compensation to victims of six toxic pollution incidents. Potential study sites were selected from this report on the basis of the background information provided on each incident.

3. Undocumented Sites Local officials associated with the sites, from the first two sources, were solicited for additional sites in their area. The recommended sites were then added to the list of potential hazardous waste study sites.

4. The following reports were also reviewed, but they did not provide any additional sites:

- EPA, Remedial Actions at Hazardous Waste Sites, Survey and Case Studies.
- EPA, Damages and Threats Caused by Hazardous Material Sites.

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[16]**See** References at the end of Appendix B.

References

U.S. Congress, Senate Committee on Environment and Public Works. Six Case Studies of Compensation for Toxic Substances Pollution: Alabama, California, Michigan, Missouri, New Jersey, Texas. Serial No. 96-13, 96th Congress, 2nd Session, (Washington, D.C.: Government Printing Office, 1980).

U.S. Environmental Protection Agency, Damages and Threats Caused by Hazardous Materials Sites, EPA-430-9-80-004, (Washington, D.C.: U.S. EPA, May 1980).

__________, Hazardous Site Control Division, Office of Emergency and Remedial Response, Interim Priority List (Superfund List), (Washington, D.C.: October 23, 1981).

__________, Oil and Special Materials Control Division, Remedial Actions at Hazardous Waste Sites, Survey and Case Studies, EPA-430-0-81-0059, by N. Neely, D. Gillespie, F. Schauf and J. Walsh (Washington, D.C.: U.S. EPA, January 1981):